Abstract Title Page
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Title: Testing for thresholds in associations between child care quality and child outcomes.

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Abstract Body
Limit 5 pages single spaced.

Background/context:
Description of prior research, its intellectual context and its policy context.

Over the past five decades, the federal government and most states have invested heavily in providing publicly-funded child care and early education opportunities for three- and four-year-old children from low-income families. Policy makers and parents want to identify *the level* or *threshold* in quality of teacher-child interaction related to better child outcomes to most efficiently use child care to improve school readiness.

Most of the literature has examined linear associations, yielding findings that higher quality is better and lower quality is worse (Vandell, 2004), but identification of thresholds in the association between quality and child outcomes has been a goal of researchers and policy makers for several reasons. A primary goal has been to identify levels in the association between quality and child outcomes at which the linear association begins to asymptote or level off, above or below which there is little evidence of increases in learning associated with increased in quality. A threshold that indicated that the quality-outcome association level off above a given level of quality would suggest that policies should focus on improving quality up to that threshold level, but improving quality above that point may not be necessary for improving child outcomes. Policy to address this goal would invest in lower or average quality classrooms while leaving classroom with quality scores above the threshold alone. In contrast, it is possible a threshold could define the minimum level at which a positive association between quality and outcomes is observed. In this scenario, there may be no detected relation between quality and outcome gains until quality reached a certain point on the scale; in other words, learning did not take place until classrooms demonstrated a minimal level and after that minimum, gains in learning increased as quality increased. This form of threshold effect would suggest that it is especially important to ensure that children experience at least the minimum level of quality child care in order for those experiences to be related to improved child outcomes. It would point perhaps to not allowing vouchers to pay for care that was below the threshold, while also incentivizing teachers above the threshold to continue to improve. One can see how the examination of thresholds may have considerable implications for the efficient and effective expenditure of funds, not only in relation to providing access to quality of a certain minimal level, but also in the targeting of funds to improve quality.

Whether there was any evidence of thresholds in the association between quality of center-based child care and gains in academic and social skills was examined in 5 large studies of child care experiences of children from low-income families. Using a quadratic or spline regression approaches, findings suggested that teacher sensitivity was related to higher levels of social competence and lower levels of behavior problems only in high-quality classrooms

Setting:
Description of where the research took place.

All data included in these secondary data analyses were collected in preschool center-based care.

Population / Participants / Subjects:
Description of participants in the study: who (or what) how many, key features (or characteristics).

We examined the association between child care quality and child outcomes among low-income children. We selected five data sets that included child care quality and child outcome assessments for at least 100 children observed in at least 50 classrooms. The data included in this analysis from the NICHD Study of Early Child Care and Youth Development (NICHD SECCYD; NICHD ECCNR, 2003) and Cost, Quality, and Outcomes Study (CQO; Peisner-Feinberg & Burchinal, 1997) examined 4-5 year-old children in center-based community settings. The National Center for Early Development and Learning (NCEDL) examined children attending randomly selected state pre-kindergarten programs in 11 state chosen because they had mature large pre-kindergarten programs (Howes et al., 2008). The Head Start Experience Survey (FACES) from 1997 and 2000 provided a representative sample of children attending Head Start during those years..   The complete data were available for the first three studies and the public release data sets were acquired for the FACES data sets.

The NICHD SECCYD was designed to examine the relationship between child care experiences and characteristics and children's developmental outcomes. The participating children were a conditional random sample selected shortly after birth during hospital visits at ten locations across the U.S. The locations were associated with the 10 principle investigators, but include sites in the Northeast, Southeast, Midwest, and West. Data were collected in whatever care and education setting the children attended. The current analyses include ECE setting and child assessments 54 months. For more information on this study's methodology, see *https://secc.rti.org* or a report by NICHD study (NICHD ECCRN, 2006).

The CQO was conducted in child care centers in four states. The centers were randomly selected from lists of for-profit and not-for-profit centers in the greater Los Angeles area of California, the Frontal Range area of Colorado, the greater Hartford area of Connecticut, and greater Greensboro area of North Carolina. Costs and quality of care in a randomly selected infant/toddler and preschool classroom were carefully assessed in 101 centers. Up to 10 children in the preschool classrooms were randomly selected and their academic, language, and social skills were assessed in the spring of their second-to-last year of child care (see Peissner-Feinburg & Burchinal, 1997 for details).

NCEDL conducted two studies of state-funded pre-kindergarten: the Multi-State Study of Pre-Kindergarten and the Study of State-Wide Early Education Programs (SWEEP). The goals and methodologies of the two studies were largely similar, so they have been combined for the current analyses. Both studies sought to describe state-funded pre-kindergarten programs in states that had large, well-established programs. In all, 11 states participated. In each state, sites were randomly selected from lists provided by the states of sites providing state funded pre-kindergarten. Then, in each site, one classroom serving primarily 4-year olds was selected at random. Within each classroom, 4 children who were old enough to attend kindergarten the following year were selected. The current analyses include children's assessments from the fall and spring of the pre-kindergarten year. For further details about the methodologies for these studies see Early et al. (2005).

The primary purpose of the FACES was to describe the quality of Head Start programs in a nationally representative sample, toward the goal of implementing a system of program performance measures and improving accountability for Head Start programs. The sample

comprising this longitudinal dataset consisted of 63 randomly selected Head Start programs, stratified by census region, percent minority, and urbanicity. The FACES cohorts from 1997 and 2000 feature four phases of data collection and follow 4-year old Head Start children from program entry through the spring of kindergarten. The current analyses are restricted to children who were in 4 year-old classrooms in spring of either 1997 or 2000 and include children's assessments from the fall and spring of their first year of Head Start. For more information on this study and its methodology, see Zill and Resnick (2005) and Zill et al. (2003).

Measures

Five measures of ECE quality were collected across the studies. The Early Childhood Environment Rating Scale *(ECERS; Harms & Clifford, 1980) or the* Early Childhood Environment Rating Scale-Revised *(ECERS-R; Harms, Clifford, & Cryer, 1998) was collected in all studies but SECCYD. It is a widely used measure of global classroom quality, specifically designed for use in classrooms serving children between 2½ and 5 years of age. Scores on the ECERS-R range from 1-7 with 1 indicating "inadequate" quality, 3 indicating "minimal" quality, 5 indicating "good" quality, and 7 indicating "excellent" quality. The* Observational Record of the Caregiving Environment *(ORCE) was designed specifically for the SECCYD to assess the quality of caregiver-child interaction experienced by individual children. Observations of child care quality used in the present analyses were made during a single half-day visit when the child was 54 months of age. The quality measure used for the current project is the positive caregiving rating composite, the mean of 4-point ratings of caregivers' sensitivity/responsivity, stimulation of cognitive development, intrusiveness (reflected), and detachment (reflected). Scores range from 1 (unresponsive or harsh caregiving) to 4 (frequent responsive and stimulating caregiving). The* Caregiver Involvement Scale *(CIS; Arnett, 1989) was collected in CQO and the FACES studies. It is an observational scale consisting of 26 items reflecting teacher sensitivity, harshness, and detachment that are rated on a 1-4 scale indicating how characteristic they are of the teacher, from not at all (1) to very much (4). Psychometric analyses suggest a single factor most parsimoniously represented these data (Cronbach's α = .93). The* Classroom Assessment Scoring System *(CLASS; Pianta, La Paro, & Hamre, 2008) was used in NCEDL to rate teacher-child interactions in terms of emotional support, in terms of sensitivity and responsiveness p, and instructional support in terms of developing concepts and providing productive feedback.*

The projects also used a variety of measures to assess child outcomes (see Table 3). All of the projects but CQO administered the same battery of assessments in the fall and spring. All studies measured language. CQO, NCEDL, and the FACES studies used the *Peabody Picture Vocabulary Test-Revised* (PPVT; Dunn & Dunn, 1997. The SECCYD used the *Preschool Language Scale-3* (PLS-3; Zimmerman, Steiner, & Pond, 1992). According to the developers, both measure receptive language reliably for 3-5 year-olds (PPVT 92 -.98; PLS-3 .89-.92). All studies administered two subtests from the *Woodcock-Johnson Tests of Achievement* (WJ), the Letter-Word Identification subtest to measure early reading skills and the Applied Problems Subtest to measure early math skills. NCEDL used the Woodcock-Johnson III (Woodcock, McGrew, & Mather, 2001). According to the developer, reliability for 3- to 5-year-old children range .92 to .99 for Letter-Word and .91 to .94 for Applied Problems. All of the language and academic achievement measures are individually-administered standardized tests with mean of 100 and standard deviation of 15 in the norming sample.

The five studies administered a variety of measures of social/emotional development. The SECCYD had teachers complete the *Child Behavior Checklist* (CBCL; Achenbach, 1991), a widely used measure of internalizing and externalizing behavior problems. The SECCYD measured social skills with the *Social Skills Rating System* (SSRS; Gresham & Elliott, 1990; test-retest reliability of .75 to .88). The CBCL has a mean of 50 and standard deviation of 10 in the norming sample.   CQO teachers rated each child on the Classroom Behavior Inventory (CBI; Schaefer, Edgerton, & Aaronson, 1978). Factor analysis of the 10 CBI scale scores from the first year resulted in three factors (75% of the variance): yielding a task orientation factor (. = .84), a social skills factor (. = .65), and a problem behaviors factor (. = .77). CBI scales are computed as the mean of items with a maximum score of 5 and minimum score of 1. NCEDL teachers completed the *Teacher-Child Rating Scale* (TCRS; Hightower et al., 1986; NCEDL), a behavioral rating scale that assesses children's social competence and problem behaviors. The Social Competence scale was computed as the mean of 20 items and had a Cronbach's α of .95. The Problem Behavior scale was computed as the mean of 18 items and had a Cronbach's α of .91. TCRS scales are also computed as the mean of items with a maximum score of 5 and minimum score of 1.   The teachers in the two FACES studies completed the 28-item *Behavior Problems Index* (Zill, 1985) to assesses problem behaviors related to emotional status, school behavior, and interpersonal relationships with items drawn from several other child behavior scales (e.g., CBCL, SSRS). Zill reported 2-week test-retest reliability of .92.

Research Design:
Description of research design (e.g., qualitative case study, quasi-experimental design, secondary analysis, analytic essay, randomized field trial).

We asked whether the reason that the associations between observed quality and child outcomes were so modest is because the association is nonlinear. We tested this hypothesis with regression analyses that included quality as both linear and quadratic terms (i.e., quality x quality) and site, maternal education, ethnicity, and gender as covariates.

Findings / Results:
Description of main findings with specific details.

First, we examined the quadratic regression. Results are shown in Table 2, listing the coefficients and standard errors in parentheses for the models in which the quality squared term was significant. Quadratic associations obtained in the analyses of the FACES 1997 data. These regressions provide a hint that quality may be more strongly related to outcomes when quality is in the higher quality range. The positive quadratic associations indicate that the association between quality and outcomes is stronger at higher levels of quality whereas a negative quadratic association indicates the association is stronger at lower levels of quality. In one study, FACES 1997, ECERS scores were positively related to language scores when quality was in the good to high range. In three studies, NCELD, SECCYD, and FACES 1997, quality was more strongly related to math skills when quality was in the good to high range. In one study, NCEDL, the two quality measures were more strongly related to reading skills when they were in the good to high

range. However, in another study, CQO, quality was more strongly related to reading when quality was in the low to average range. Finally, in two studies, NCEDL and FACES 1997, quality was more strongly negatively related to behavior problems when quality was in the good to high range.

Second , a spline regression approach was used with NCEDL to test whether the linear regression of child outcomes onto child care quality for low- or average-quality programs was different than that for high- quality programs. A repeated-measures hierarchical linear model was fit to account for nesting of children within classrooms. Therefore, there was one residual term that has taken into account the clustering within classroom and an independent residual term that represented error in the individual children's scores. The model estimated separate "splines" or linear regressions for programs considered to be lower quality and higher quality, thereby estimating one slope for describing the association between quality and outcomes for programs in the higher-quality range and another slope for programs in the lower-quality range.

Emotional Support. The spline regressions tested whether Emotional Support predicted the six outcomes overall and whether the magnitude of prediction was stronger in higher-quality classrooms (i.e., classrooms with a score of 5 or higher) than in lower-quality classrooms. Results, indicated that Emotional Support was a more positive predictor of social competence and negative predictor of behavior problems in classes in the high range on Emotional Support than in classes in the low/medium range. Effect sizes were plotted in Figure 1. Emotional Support was more strongly positively related to teacher ratings of social competence in high-quality ($B = .09$, $d = .08$) than in moderate-to-low-quality classrooms ($B = -.01$, $d = .01$). Similarly, Emotional Support was more strongly negatively related to teacher ratings of behavior problems in high-quality ($B = -.10$, $d = -.12$) than in moderate-to-low-quality classrooms ($B = .03$, $d = .04$). Emotional Support predicted these two social outcomes in the hypothesized direction only in the higher-quality classrooms; it was a nonsignificant predictor of social competence and a positive predictor of behavior problems in moderate-to-low-quality classrooms.

Instructional Quality.   Instructional Quality was related to three of the four academic outcomes in these spline regressions. As shown in Figure 2, children who experienced higher-quality Instructional Quality (i.e., classrooms with a score of 3.25 or higher) tended to score higher on expressive language and math overall, but the magnitude of that association was stronger in higher-quality classrooms for reading, math, and expressive language.   Instructional Quality predicted outcomes more strongly in higher-quality than lower-quality programs on expressive language (Higher: $B = 3.97$, $d = .23$; Lower $B = 1.34$, $d = .08$), reading (Higher: $B = 5.54$, $d = .17$; Lower $B = .70$, $d = .02$), and math (Higher: $B = 8.30$, $d = .34$; Lower $B = 2.52$, $d = .02$).

Conclusions:
Description of conclusions and recommendations based on findings and overall study.

In conclusion, findings from this study suggest that moderately high- to high-quality classrooms may be necessary to optimally improve social skills, reduce behavior problems, and promote reading, math, and language skills. Unlike the expected threshold levels suggesting there was a "good-enough" level, these findings suggest that children may not obtain social and academic benefits from pre-kindergarten experiences unless the teacher maintains high-quality teacher-child interactions and at least moderate- to high-quality instruction.

Appendices
Not included in page count.

Appendix A. References

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Appendix B. Tables and Figures
Not included in page count.

Table 1 Descriptive information for the five studies on low-income children and their classrooms

		NICHD SECCYD N=129	CQO N=140	NCEDL Pre-K eval N=1465	FACES 1997 N=1493	FACES 2000 n=1739
Background						
Maternal Education	M (sd)	12.6 (1.8)	13.0 (1.7)	11.8 (1.9)	11.7 (1.9)	11.9 (1.8)
Child Gender (male)	%	48%	51%	49%	51%	50%
Child Age -months	M (sd)	54	51.1 (4.4)	60.6 (2.3)	55.4 (6.3)	54.0 (6.5)
Child Ethnicity/Race						
African-American		36.4%	32.4%	20.7%	21%	38%
Hispanic		9.3%	13.7%	36.0%	36%	29%
White		49.6%	46.0%	28.6%	29%	24%
Other		4.7%	7.9%	14.7%	14%	5%
Quality Measures						
ECERS Total	M (sd)		4.2 (.9)	3.8 (.8)	5.1 (.6)	4.9 (1.0)
Language&Reason	M (sd)		4.38 (1.40)	4.5 (1.1)	5.0 (1.0)	5.0 (1.3)
Interactions	M (sd)		4.62 (1.24)	4.7 (1.5)	5.0 (.7)	5.6 (1.6)
CIS Total	M (sd)		78.0 (10.4)		73.1 (11.1)	72.8 (13.0)
CLASS Total	M (sd)			4.5 (.6)		
Emotional Support	M (sd)			5.5 (.7)		
Instructional Supp	M (sd)			2.1 (.8)		
ORCE Total	M (sd)	2.9 (.6)				
Child Outcomes						
PPVT	M (sd)		83.6 (17.1)	92.0 (13.4)	84.1 (15.1)	84.6 (16.7)
PLS	M (sd)	86.2 (18.5)				
WJ-Letter-Word	M (sd)	91.9 (12.8)	94.7 (10.9)	99.5 (13.0)	90.2 (10.1)	92.5 (10.3)
WJ-Applied Prob	M (sd)	93.4 (15.7)	96.6 (12.8)	96.0 (12.2)	84.9 (17.7)	86.6 (17.5)
CBCL Externalizing	M (sd)	53.3 (10.0)				
CBCL Internalizing	M (sd)	52.8 (10.1)				
CPSC Socal Compet	M (sd)	98.4 (16.6)				
CBI Task Orientation	M (sd)		3.3 (1.0)			
CBI Behavior Prob	M (sd)		2.7 (1.0)			
TCRS Social Compet	M (sd)			3.6 (.8)		
TCRS Behavior Prob	M (sd)			1.5 (.6)		
BPI Social Skills	M (sd)				16.4 (4.5)	16.5 (4.6)
BPI Behavior Prob	M (sd)				4.9 (4.5)	5.5 (5.0)

Table 2. Regression Coefficients predicting child outcomes from quality as a linear and quadratic predictor

	ORCE	ECERS/ECER-R				CLASS
	SECCYD	CQO	NCEDL	FACES97	FACES00	NCEDL
Receptive Language	NS	NS	NS		NS	NS
Linear quality				-18.62**(6.01)		
Quadratic quality				1.92** (.60)		
Math-WJ Applied Prob.		NS	NS		NS	NS
Linear quality	-52.65* (23)			-20.90*(8.00)		
Quadratic quality	9.32* (4.0)			2.11**(.80)		
Reading-WJ Letter/Word	NS	17.3* (6.6)	NS	NS	NS	-14.0* (6.0)
Linear quality		-1.8* (.8)				1.70* (.70)
Quadratic quality						
Social Skills	NS	---	NS	NS	1.76*	NS
Linear quality					(.88)	
Quadratic quality					NS	
Behavior Problems	---	NS			NS	NS
Linear quality			.35*	-5.70** (2.00)		
Quadratic quality			(.15)	.64** (.20)		
			.04*			
			(.02)			

Note: all analyses adjusted for site, maternal education, gender, and ethnicity. * p <.05; ** <.01; *** p<.001

Figure 1: NCEDL Spline regression results: Emotional Support effect sizes for high- and moderate-to-low-quality classrooms
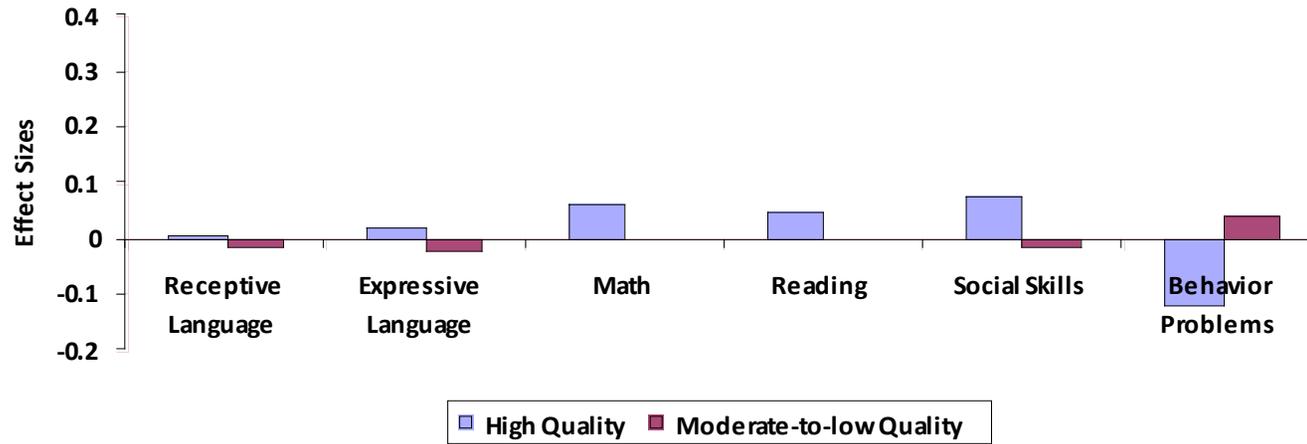
Figure 2: NCEDL Spline regression results Instructional Quality effect sizes for moderate-to-high- and low-quality classrooms